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Utility Patent Application Transmittal  
(Only for new non-provisional applications Under 37 CFR 1.53(b))

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Washington, D. C. 20231

Case Docket No. 0325.00355  
Date: June 13, 2000

Sir:

Transmitted herewith for filing is a patent application of:

Inventor(s): Padma S. Nagarasa, Pidugu L. Narayana and Beng-Ghee Teh

For: CONFIGURABLE DATA SETUP/HOLD TIMING CIRCUIT

Enclosed are:

1. ☒ Specification (10 pages); Claims (5 pages); Abstract (1 page)
2. ☒ 4 sheets of formal drawings.
3. ☒ Oath or Declaration Total Pages 3
  - a. ☒ Newly executed (original or copy)
  - b. ☐ Copy from a prior application (37 CFR 1.63(d))  
(for continuation/divisional with Item 5 completed)
  - c. ☐ Copy of Revocation of Previous Power
4. ☐ Incorporation By Reference (usable if Item 3b is checked)  
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Item 3b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
5. ☐ If a Continuing Application, check appropriate box and supply the requisite information below and in a preliminary amendment:  
☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP)  
of prior application no.:
6. ☒ An assignment to CYPRESS SEMICONDUCTOR CORP. along with PTO form 1595.
7. ☐ A PTO Form 1449 with a copy of the references not previously cited.
8. ☒ Return Receipt Postcard
9. ☐ Other:

09592207, 061300

	No. Filed	No. Extra	Fee	Amount
Basic Fee	--	--	--	\$690.00
Total Claims	20	0	x \$ 18.00	\$ 0.00
Indep. Claims	3	0	x \$ 78.00	\$ 0.00
Mult. Dep. Claims			\$260.00	\$ 0.00

TOTAL ..... \$730.00

X The Commissioner is hereby authorized to charge any fees under 37 CFR 1.16 and 1.17 which may be required by this paper or associated with this filing to Deposit Account No. 50-0541. A duplicate copy of this sheet is enclosed.

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PATENT TRADEMARK OFFICE

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**Attorney Docket No.: 0325.00355**

**CONFIGURABLE DATA SETUP/HOLD TIMING CIRCUIT**

**Field of the Invention**

The present invention relates to a method and architecture for configuring a data setup/hold time generally and, more particularly, to a method and architecture for implementing a configurable data setup/hold timing circuit.

**Background of the Invention**

Conventional data setup/hold timing circuits provide non-variable data setup/hold timing. Data setup is defined as the time the data should be present at an input before a clock signal arrives. Data hold is defined as the time the data should be held at the input after the clock signal arrives.

Referring to FIG. 1, a conventional circuit 10 requiring an aggressive data setup time is shown. The circuit 10 comprises a first circuit, such as an application specific integrated circuit (ASIC) 12 and a second circuit, such as a first-in first-out FIFO 14. A clock signal CLK is presented to an input 16 of the ASIC 12 and to an input 18 of the FIFO 14. The ASIC 12 presents a data signal DATA to the FIFO 14 in response to the system clock CLK.

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The FIFO 14 requires an aggressive setup time since both the ASIC 12 and the FIFO 14 are driven by the system clock CLK.

Referring to FIG. 2, a conventional circuit 20 requiring an aggressive data hold time is shown. The circuit 20 comprises a logic block 22 and a FIFO 24. The logic block 22 receives a data signal DATA. Additionally, the logic block 22 presents the data signal DATA and a clock CLK to the FIFO 24. The FIFO 24 requires an aggressive hold time, because the clock CLK and the data presented to the FIFO 24 are serially connected between the logic block 22 and the FIFO 24.

The conventional FIFOs 14 and 24 have non-optimal data setup/hold timing. The conventional FIFOs 14 and 24 are limited, since they introduce performance degradation.

## Summary of the Invention

The present invention concerns an apparatus comprising a first delay circuit. The first delay circuit may be configured to present a data delayed signal having one of a plurality of delay times. The plurality of delay times may provide a user configurable setup/hold time.

The objects, features and advantages of the present invention include providing a method and/or architecture for implementing a configurable data setup/hold time that may (i) provide an optimal data setup time, (ii) provide an optimal data hold time, (iii) reduce performance degradation and/or (iv) provide user configurable delay parameters.

#### **Brief Description of the Drawings**

These and other objects, features and advantages of the present invention will be apparent from the following detailed description and the appended claims and drawings in which:

FIG. 1 is a block diagram of a conventional timing circuit illustrating an aggressive data setup time;

FIG. 2 is a block diagram of a conventional timing circuit illustrating an aggressive data hold time;

FIG. 3 is a block diagram of a preferred embodiment of the present invention;

FIG. 4 is a detailed block diagram of a delay block of FIG 3; and

FIG. 5 is a more detailed block diagram of the present invention.

**Detailed Description of the Preferred Embodiments**

Referring to FIG. 3, a block diagram of circuit 100 is shown in accordance with a preferred embodiment of the present invention. The structure of the circuit 100 generally comprises a delay block (or circuit) 101 and a register block (or circuit) 102. The circuit 100 may be implemented, in one example, as a configurable data setup/hold timing circuit. In another example, the circuit 100 may be implemented as a configurable register timing circuit. The circuit 100 may provide an optimal balance data setup/hold time that may be adjusted for various operational implementations. The circuit 100 may reduce performance degradation as a result of data setup and/or hold times. Additionally, the circuit 100 may be user configurable.

The delay circuit 101 may have an input 103 that may receive a signal (e.g., S\_H), an input 104 that may receive a signal (e.g., DIN) and an output 105 that may present a signal (e.g., DIN\_DLY). The signal DIN\_DLY may be presented to an input 106 of the register 102. The register 102 may also have an input 107 that may receive a signal (e.g., CLK). The register 102 may present a signal (e.g., DOUT). In one example, the signal S\_H may be implemented as a setup and hold time configuration signal and

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the signal DIN\_DLY may be implemented as a delayed data signal. In another example, the signal S\_H may be implemented as a user configurable signal. For example, the signal S\_H may be configured/programmed in a number of ways such as (i) a control interface, (ii) a number of input pins, (iii) software instructions, and/or (iv) hardware. However, the signal S\_H and the signal DIN\_DLY may be implemented as other appropriate signal types in order to meet the criteria of a particular implementation.

Referring to FIG. 4, a detailed block diagram of the delay circuit 101 is shown. The delay circuit 101 may be implemented, in one example, within an JTAG port. The delay circuit 100 may comprise a high speed transceiver logic (HTSL) block (or circuit) 108, a plurality of delay blocks (or circuits) 109a-109n, and a switch 111. The HTSL circuit 108 may be compliant with the JEDEC specification for input/output interfaces, which is hereby incorporated by reference in its entirety). The HTSL circuit 108 may be programmed to implement a variety of common applications. For example, the HTSL circuit 108 may be programmed to control data input to the delay blocks 109a-109n. HSTL is the JEDEC standard for input/output interfaces in low voltage designs (e.g., 2.5V and under). Since the voltage swings on HSTL inputs

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and outputs are much smaller (e.g., 0-1.5V range with rise and fall times of 0.5ns (edge rates of 2v/ns)), appropriate setup/hold timing is important. However, the present invention is applicable to other technologies, such as TTL, CMOS, etc.

5           The HSTL circuit 108 may have an input 112 that may receive the signal DIN. The signal DIN may be implemented, in one example, as an externally generated data input signal. The HSTL circuit 108 may have an output 113 that may present a signal to an input 114a of the delay circuit 109a and to an input 114n of the delay circuit 109n. The particular number of delay blocks 109a-109n may be varied to meet the criteria of a particular implementation. For example, by implementing more delay blocks 109a-109n, a larger number of programmable delay choices may be implemented.

15           The delay circuits 109a-109n may each have an output 116a-116n that may present a signal to an input 118a-118n of the switch 111. The switch 111 may have an input 130 that may receive the signal S\_H. In one example, the signal S\_H may be implemented as a multi-bit setup and hold configuration signal. In one  
20 example, the signal S\_H may be either a high state (e.g., "1") or a low state (e.g., "0").



The various signals are generally "on" (e.g., a digital HIGH, or 1) or "off" (e.g., a digital LOW, or 0). However, the particular polarities of the on (e.g., asserted) and off (e.g., de-asserted) states of the signals may be adjusted (e.g., reversed) accordingly to meet the design criteria of a particular implementation.

The switch 111 may select at least one of the outputs of the delay circuits 109a-109n. The switch 111 may select the appropriate delay circuit 109a-109n in response to the signal S\_H. The signal S\_H may be implemented to provide any appropriate delay in order to meet the criteria of a particular implementation. Additionally, the signal S\_H may be generated by any appropriate type device and/or configuration in order to meet the criteria of a particular implementation. The switch 111 may have an output 140 that may present the signal DIN\_DLY. The switch 111 may allow the circuit 100 to provide an optimal data setup-hold window. Additionally, the switch 111 may allow the user to select an appropriate delay parameter. The signal DIN\_DLY may be implemented, in one example, as a delayed data signal.

The circuit 100 generally starts operation when the signal is presented to the delay block 101. The delay block 101

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may provide a data delay (e.g., the signal DIN\_DLY) of the input data DIN. The register 102 may receive the delayed data signal DIN\_DLY. Additionally, the register 102 may present the signal DOUT in response to the clock CLK. A particular delay length of the signal DIN may be determined in response to the signal S\_H. The switch 111 may determine which delay circuit 109a-109n to select in response to the signal S\_H. The signal S\_H may be implemented, in one example, as a user configuration setup and hold timing signal. In another example, the signal S\_H may be implemented as a multi-bit signal. The delay circuits 109a-109n may each be implemented with a different delay length. The data input DIN may be delayed according to a selection of an appropriate delay (e.g., the delay circuits 109a-109n).

Referring to FIG. 5, a detailed block diagram of the circuit 100 is shown. The circuit 100 of FIG. 5 illustrates an overall detailed implementation of the present invention. The circuit 101 may comprise the HSTL block 108, the delay devices 109a-109n and the multiplexer 111. The register 102 may be implemented, in one example, as a "D" type register. However, the register 102 may be implemented as another appropriate type

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register in order to meet the criteria of a particular implementation.

The circuit 100 may provide optimal setup and hold timing solutions. The circuit 100 may provide a configurable delay for  
5 (i) data and/or (ii) clock signals. The circuit 100 may overcome performance degradation associated with a single timing setup. The circuit 100 may provide reduced performance degradation of data setup and/or hold times. Additionally, the circuit 100 may provide a user configurable delay.

10 The circuit 100 has been described in the context of the example of two delay elements. However, a number of delay elements may be implemented accordingly to meet the design criteria of a particular implementation. For example, a plurality of delay elements 109a-109n may be implemented to provide a variety of  
15 programmable delay times for the signal DIN\_DLY. In general, particular design parameters may dictate that a fast or a slow delay time of the signal DIN\_DLY may be required. For example, one of the delay elements 109a-109n may be appropriate to provide timing that may be used with a circuit such as the circuit 10 of  
20 FIG. 1. Furthermore, another one of the delay elements 109a-109n may provide a delay of the signal DLY appropriate with a circuit

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such as the circuit 20 of FIG. 2. Furthermore, another of the delay elements 109a-109n may be programmed to provide a delay appropriate for another design application. When the number of delay elements is greater than two, the signal S\_H may be implemented as a multi-bit signal. In one example, the signal S\_H may be received from an external pin. However, the signal S\_H may be received from other sources, such as an internal register, control interface, software instructions, a microprocessor, etc.

While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made without departing from the spirit and scope of the invention.

**CLAIMS**

1. An apparatus comprising:

a first delay circuit configured to present a data delayed signal having one of a plurality of delay times, wherein said plurality of delay times provide a user configurable setup/hold time.

2. The apparatus according to claim 1, further comprising:

a second circuit configured to receive said data delayed signal and present a data output.

3. The apparatus according to claim 2, wherein said second circuit comprises a register that is further configured in response to a clock signal.

4. The apparatus according to claim 1, wherein said first delay circuit further comprises an HSTL circuit configured to present a first signal in response to a data input.

5. The apparatus according to claim 4, wherein said first delay circuit further comprises one or more delay circuits each configured to present an output delay signal in response to said first signal.

6. The apparatus according to claim 5, wherein said first delay circuit further comprises a switch configured to receive said one or more output delay signals and present said data delayed signal.

7. The apparatus according to claim 6, wherein said switch is further configured in response to a user configuration signal.

8. The apparatus according to claim 7, wherein said user configuration signal comprises a setup and hold timing configuration signal.

9. The apparatus according to claim 7, wherein said user configuration signal comprises a programmable signal.

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10. The apparatus according to claim 7, wherein said user configuration signal comprises a multi-bit signal.

11. An apparatus comprising:

means for receiving an input signal; and

means for presenting a data delayed signal having one of a plurality of delay times to provide a user configurable setup/hold time.

12. A method for programming a data delayed signal, comprising the steps of:

(A) receiving an input signal; and

(B) configuring said data delayed signal having a plurality of delay times to provide a user configurable setup/hold time.

13. The method according to claim 12, further comprising the steps of:

(C) storing said data delayed signal and presenting a data output signal.

14. The method according to claim 13, wherein step (C) is further configured in response to a clock signal.

15. The method according to claim 12, wherein step (B) further comprises presenting a first signal in response to said input signal.

16. The method according to claim 15, wherein step (B) further comprises presenting one or more output delay signals in response to said first signal.

17. The method according to claim 16, wherein step (B) further comprises receiving said one or more output delay signals and presenting said data delayed signal.

18. The method according to claim 17, wherein step (B) further comprises switching said one or more output delays in response to a user configuration signal.



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19. The method according to claim 18, wherein said user configuration signal comprises either (i) a setup and hold timing configuration signal or (ii) a multi-bit signal.

20. The method according to claim 18, wherein said user configuration signal comprises a programmable signal.

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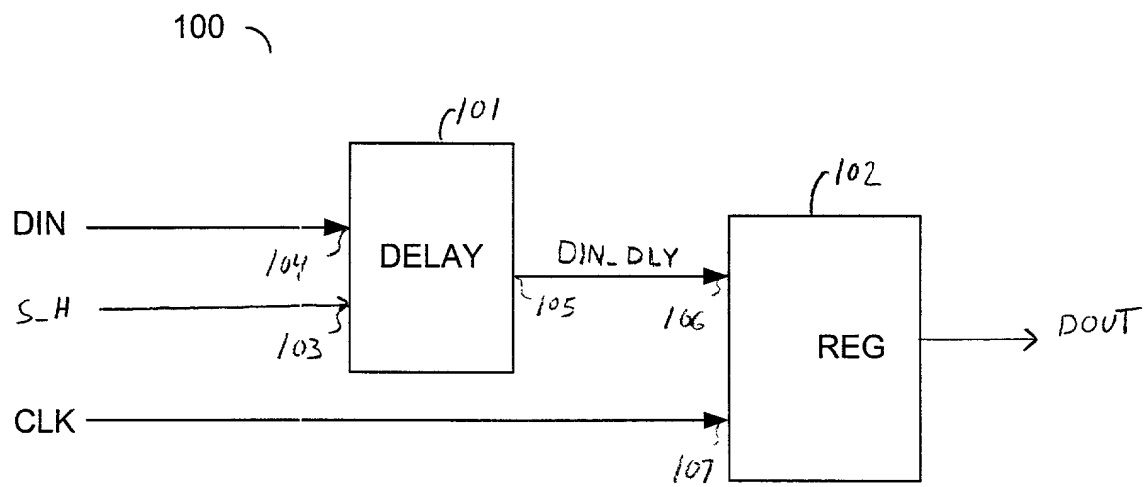


FIG. 3

100~

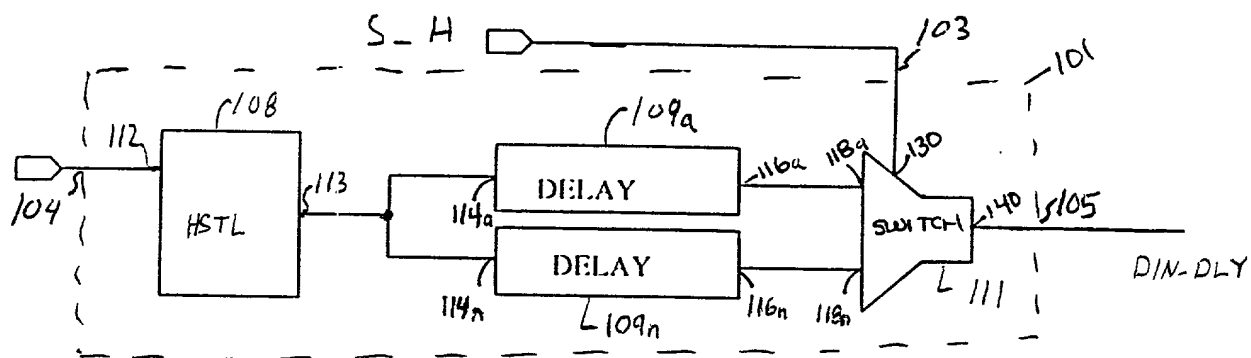


FIG.4

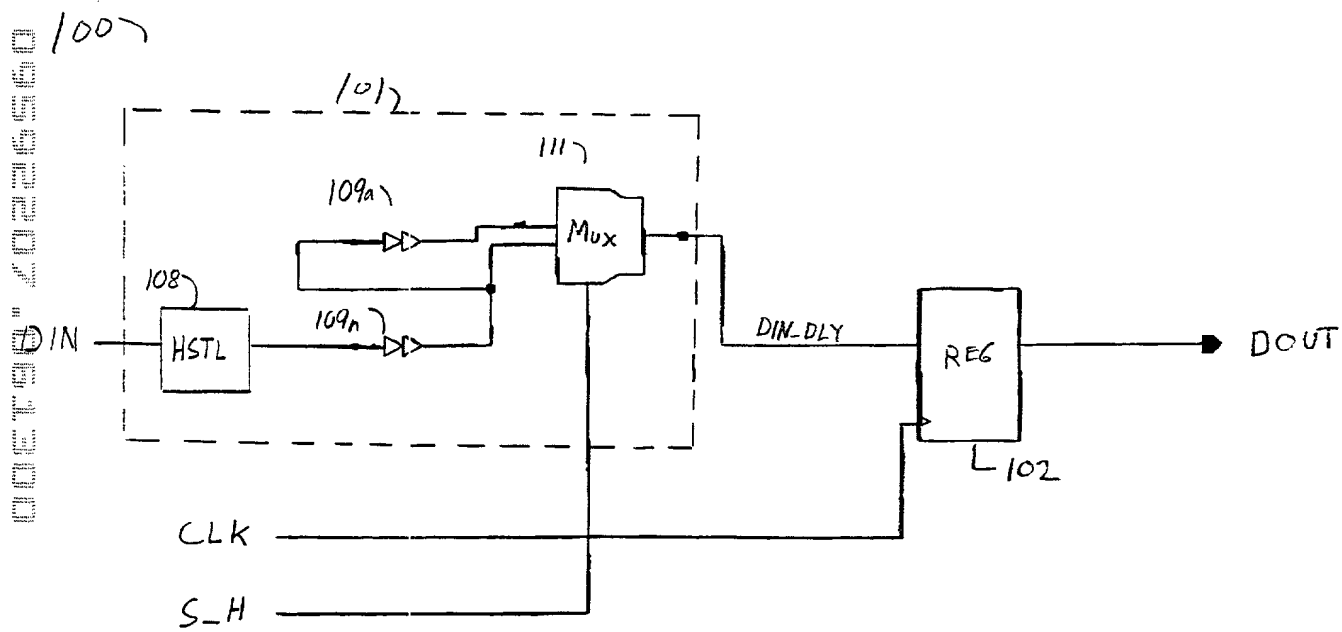


FIG.5

Docket No. 0325.00355

**DECLARATION, POWER OF ATTORNEY AND PETITION**

We, the undersigned inventors, hereby declare that:

My residence, post office address and citizenship are given next to my name;

We believe that we are the first, original and joint inventors of the subject matter claimed in the application for patent entitled "**CONFIGURABLE DATA SETUP/HOLD TIMING CIRCUIT**", which:

  X   is submitted herewith;

           was filed on            as Application Serial No.            and amended on           ;

We have reviewed and understand the contents of the above-identified application for patent (hereinafter, "this application"), including the claims;

We acknowledge the duty under Title 37, Code of Federal Regulations, Section 1.56, to disclose to the United States Patent and Trademark Office information known to be material to the patentability of this application. We also acknowledge that information is material to patentability when it is not cumulative to information already provided to the United States Patent and Trademark Office and when it either

compels, by itself or in combination with other information, a conclusion that a claim is unpatentable under the preponderance of evidence standard, giving each term in the claim its broadest reasonable construction consistent with the application, and before any consideration is given to evidence which may be submitted to establish a contrary conclusion of patentability, or

refutes or is inconsistent with a position taken in either (i) asserting an argument of patentability, or (ii) opposing an argument of unpatentability relied on by the United States Patent and Trademark Office;

We hereby claim the priority benefit under Title 35, Section 119(e), of the following United States provisional patent applications:

Application No.

Filing Date

We hereby claim the priority benefit under Title 35, Section 120, of the following United States patent applications:

Serial No.

Filing Date

Status

Docket No. 0325.00355

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We hereby claim the priority benefit under Title 35, Section 365(c), of the following PCT International patent applications designating the United States:

Application No.

Filing Date

Where the subject matter of the claims of this application is not disclosed in the United States or PCT priority patent applications identified above, we acknowledge the duty to disclose information known to be material to the patentability of this application that became available between the filing dates of this application and of the priority United States or PCT patent applications.

We hereby appoint as our attorneys with full power of substitution to prosecute this application and conduct all business in the United States Patent and Trademark Office associated with this application: Customer No. 021363.



**21363**

PATENT TRADEMARK OFFICE

We declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this application or any patent issuing thereon.

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